REMARKS

This Amendment is filed in response to the Final Office Action mailed on May 30, 2007, and is herewith filed a Request for Continuing Examination. All objections and rejections are respectfully traversed.

Claims 1-22, 38, 40-41, 43-44, 46, 55-83 are currently pending.

Claims 84 is added.

Request for Interview

The Applicant respectfully requests a telephonic interview with the Examiner after the Examiner has had an opportunity to consider this Amendment, but before the issuance of the next Office Action. The Applicant may be reached at 617-951-3067.

Double Patenting Rejection

At paragraph 5 of the Office Action, claims 1-4, 10-11,17-18, 20-21, 38, 40, 41,43, 44, 55-56, 62, 64, 69, 71-73, 76, and 77-81 were rejected on the ground of non-statutory obviousness-type double patenting as being unpatentable over U.S. Patent No. 6,851,082.

Applicant respectfully urges that the conflicting patent 6,851,082 and the present application are commonly owned. Accordingly, a terminal disclaimer has been timely filed herewith in compliance with 37 C.F.R. 1.321 to overcome the rejections based on the non-statutory double patenting ground.

Claim Rejections – 35 USC § 103

At paragraph 6 of the Office Action, claims 1-6, 8-12, 14-22, 55-58, and 61-83 are rejected under 35 U.S.C. §103 as being unpatentable by Stallmo et al., US Patent No. 6,052,759, issued on April 18, 2000, hereinafter Stallmo, over Baylor et al., US Patent No. 5,862,158, hereinafter Baylor

The present invention, as set forth in representative claim 1, comprises in part:

> 1. A method for enabling parity declustering in a balanced parity array of a storage system, comprising:
> *combining a plurality of unbalanced parity stripe arrays to form the balanced parity array, the balanced parity array storing substantially the same number of parity blocks on all disks, each unbalanced parity stripe array and the balanced parity array having parity blocks on a set of storage devices that are disjoint from a set of storage devices storing data blocks, <u>wherein each unbalanced parity stripe array is an arrangement having fewer parity blocks per disk than data blocks per disk in a stripe</u>; and*
> *distributing assignment of storage devices to parity groups throughout the balanced parity array.*

By way of background, Stallmo describes a redundant array of independent disks (RAID) system for organizing data across <u>a single array of disks</u> when disks are added and removed. Stallmo's process of combining parity (Fig. 12, 14 and 15) onto a single disk requires swapping parity blocks and data blocks to go from a RAID 5 implementation to a RAID 3 implementation. (Col. 14, lines 19-22). Stallmo performs this change to allow for a disk to be added or deleted from the array. Furthermore, Stallmo organizes the disks into "rectangles" where each rectangle has the same number of blocks on each disk with the first "rectangle" equal to the number of blocks in the disk with the smallest number of blocks. The disk may have more than one rectangle with except for the smallest disk. (Col. 8, lines 45-51). The "rectangles" are organized into "squares", where the

number of blocks in each "square" is equal to the number of disks in the rectangle multi-plied by the depth. (Col. 9, lines 14-20) The depth is set by the sub-system software and equal to the number of blocks that are necessary for each read or write operation. (Col. 2, lines 13-17). Stallmo organizes the data into rectangles to transform unstriped unpro-tected data into striped data or if data and parity are involved to transform from protected unstriped to protected striped.

Baylor discloses a method for storing redundant information in array of storage devices. Each data block is assigned to two different parity sets. Each parity set is stored in one parity block on separate disks of the array. In other words, each disk in the array has exactly one parity block storing one parity set of information.

Applicant respectfully urges that Stallmo and Baylor, taken alone or in combina-tion do not disclose nor suggest Applicant's claimed novel ***combining a plurality of un-balanced parity stripe arrays to form the balanced parity array, the balanced parity ar-ray storing substantially the same number of parity blocks on all disks, each unbal-anced parity stripe array and the balanced parity array having parity blocks on a set of storage devices that are disjoint from a set of storage devices storing data blocks, wherein each unbalanced parity stripe array is an arrangement having fewer parity blocks per disk than data blocks per disk in a stripe*** and ***distributing assignment of storage devices to parity groups throughout the balanced parity array***. In further detail, Applicant's invention is combining unbalanced parity arrays from separate RAID arrays to form super stripes that have balanced parity arrays. The unbalanced parity stripe array comprises an arrangement wherein the stripe depth is not uniform among the disks such that there are fewer parity blocks per disk than data blocks per disk in the stripe. The

storage devices that contain data are separate (***disjoint***) from the storage devices that contain parity. The plurality of storage devices containing parity form a parity array, which is a subset of all the disks in each RAID array. Specifically, the system combines an ***unbalanced stripe*** with at least one other unbalanced stripe to form a balanced parity array of which stores ***substantially the same number of _parity_ blocks on all disks***.

By ***distributing assignment of storage devices to parity groups throughout the balanced array***, enables Applicant's invention to handle single and double disk failures. Additionally, the number of accesses to each number of disks is reduced by distributing the parity for two separate sets of data across all disks. (See Specification page 28, line 14 to page 29, line 2, Fig. 14).

In contrast, neither Stallmo nor Baylor discloses ***_wherein each unbalanced parity stripe array is an arrangement having fewer parity blocks per disk than data blocks per disk in a stripe_***, as claimed by Applicant. Stallmo merely discloses a system of using "rectangles" and "squares" to transform the blocks from RAID 5 (parity striped across all disks) to RAID 3 (single disk of parity), where the smallest "rectangle" is equal to the size of the smallest disk and each "square" is equal to the number of disks in the rectangle times the depth. Stallmo is manipulating the data and parity blocks on the disks to have a single disk of parity in order to add a disk. In contrast, Applicant's invention is only combining unbalanced parity arrays together. Applicant's invention is not rearranging data blocks.

Additionally, Stallmo teaches away from Applicant's invention because Stallmo discloses not striping data that is part of a partial square. Stallmo states this at col.9, lines 21-30, which states:

> "Since the number of blocks in a rectangle is not necessarily an even multiple of the number of blocks in a square, there may be a "partial" at the end of the rectangle, and this partial portion contains the remaining blocks in each disk that cannot fit in a square. These partial blocks do not participate in the striping operation, described below, and thus remain un-striped. They will have data protection, however, since parity can be maintained with an un-striped configuration."

In reference to the statement above, Stallmo discloses a system that is not balanced when the size of the square is not evenly divisible into the size of the rectangle. There are blocks that are not striped, therefore Stallmo is creating an unbalanced array of disks and not a balanced array of disks. Furthermore, Stallmo does not disclose combining two unbalanced arrays to form a balanced array. Additionally, Stallmo does not disclose an unbalanced parity array or balanced parity array because Stallmo is for single disk failures, therefore only needs at most one disk for parity.

Additionally, Baylor does not disclose *__each unbalanced parity stripe array is an arrangement having fewer parity blocks per disk than data blocks per disk in a stripe__*, as claimed by Applicant. Baylor merely discloses the use of two parity blocks per a stripe. However, Baylor does not disclose combining multiple parity sets each having unbalanced parity array to form a balanced parity array.

Applicant respectfully urges that the Stallmo patent and the Baylor patent, either taken singly or taken in any combination are legally insufficient to render the presently claimed invention obvious under 35 U.S.C. § 103 because of the absence in each of the cited patents of Applicant's claimed novel *combining a plurality of unbalanced parity stripe arrays to form the balanced parity array, the balanced parity array storing substantially the same number of parity blocks on all disks, each unbalanced parity stripe array and the balanced parity array having parity blocks on a set of storage devices that are disjoint from a set of storage devices storing data blocks, <u>wherein each unbalanced parity stripe array is an arrangement having fewer parity blocks per disk than data blocks per disk in a stripe</u> and distributing assignment of storage devices to parity groups throughout the balanced parity array*.

At paragraph 7 of the Office Action, claims 38, 40-41, 43-44, and 46 were rejected under 35 U.S.C. §103 as being unpatentable over Burton et al. US Patent Application Publication 2003/0074527, filed on April 17, 2003, in view of Stallmo.

The present invention, as set forth in representative claim 38, comprises in part:

38. A method for declustering a parity array having a plurality of storage devices, comprising:
   assigning a first plurality of data and parity blocks to a first group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a first parity group, <u>wherein the parity blocks are striped across the plurality of storage devices in the first parity group with fewer parity blocks per storage device than data blocks per storage device in a stripe</u>;
   assigning a second plurality of data and parity blocks to a second group, where the data blocks are stored on a plurality of storage devices

that are disjoint from a plurality of storage devices storing parity blocks to form a second parity group, <u>wherein the parity blocks are striped across the plurality of storage devices in the second parity group with fewer parity blocks per storage device than data blocks per storage device in a stripe</u>, wherein the first and second parity groups being independent from each other; and

    combining the first parity group and the second parity group to form a balanced parity array, the balanced parity array storing substantially the same number of parity blocks on the storage devices configured to store parity.

By way of background, Burton describes a system for a user to create a span of disks. The system wants a balanced number of disks in each span to maximize cache utilization. With more disks per span, fewer stripes are necessary to store all the cache information.

Applicant respectfully urges that Burton and Stallmo taken alone or in combination do not teach nor suggest Applicant's claimed *assigning a first plurality of data and parity blocks to a first group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a first parity group, <u>wherein the parity blocks are striped across the plurality of storage devices in the first parity group with fewer parity blocks per storage device than data blocks per storage device in a stripe</u>... assigning a second plurality of data and parity blocks to a second group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a second parity group, <u>wherein the parity blocks are striped across the plurality of storage devices in the second parity group with fewer parity blocks per storage device than data blocks per storage device in a stripe</u>, wherein the first and second parity groups*

being independent from each other...combining the first parity group and the second parity group to form a balanced parity array, the balanced parity array storing substantially the same number of parity blocks on the storage devices configured to store parity. In further detail, Applicant's invention arranges the disks to have data disks and parity disks, where the parity disks form a parity array. The parity disks are separate disks from the data disks. A first parity group is stored on the parity disks of the first unbalanced parity array, where the first parity array stores parity blocks for a first RAID group. The second parity group is stored on the parity disks of the second unbalanced parity array, where the second parity array stores parity blocks for a second RAID group. There are gaps in locations of where parity is stored for example with an even number of disks (n) there can be no delta of n/2 because if two disks were half the length of the array apart were lost then, the data blocks members of the same two parity sets are lost, thereby obviating recovery of the lost data. (Specification page 20, line 1-26). When the two groups are combined, a balanced parity array forms combining an unbalanced parity array from first parity group and the second parity group.

In contrast, there is no disclosure in either Stallmo or Burton of *the parity blocks are striped across the plurality of storage devices in the first parity group with fewer parity blocks per storage device than data blocks per storage device in a stripe*, as claimed by Applicant. Specifically, there is no suggestion in Stallmo because it only discloses single disk failure which only requires a single disk of parity to protect the data. Additionally, Stallmo also discloses rotating the parity through all disks instead of just storing all the parity on a single disk. Furthermore, Burton only describes balancing the

number of disks in each span and not combining parity groups to form a balanced array

with approximately the same number of blocks per all disks. Additionally, neither dis-

closes combining parity blocks from separate parity arrays to form a balanced parity ar-

ray with parity blocks from two separate RAID groups.

Accordingly, Applicant respectfully urges that the Stallmo patent and the Burton

patent, either taken singly or taken in any combination are legally insufficient to render

the presently claimed invention obvious under 35 U.S.C. § 103 because of the absence in

each of the cited patents of Applicant's claimed novel *assigning a first plurality of data*

and parity blocks to a first group, where the data blocks are stored on a plurality of

storage devices that are disjoint from a plurality of storage devices storing parity blocks

to form a first parity group, <u>wherein the parity blocks are striped across the plurality of</u>

<u>storage devices in the first parity group with fewer parity blocks per storage device</u>

<u>than data blocks per storage device in a stripe</u>... assigning a second plurality of data

and parity blocks to a second group, where the data blocks are stored on a plurality of

storage devices that are disjoint from a plurality of storage devices storing parity blocks

to form a second parity group, <u>wherein the parity blocks are striped across the plurality</u>

<u>of storage devices in the second parity group with fewer parity blocks per storage device</u>

<u>than data blocks per storage device in a stripe</u>, wherein the first and second parity

groups being independent from each other...combining the first parity group and the

second parity group to form a balanced parity array, the balanced parity array storing

substantially the same number of parity blocks on the storage devices configured to

store parity.

At paragraph 8 of the Office Action, claims 7, 13, and 59-60 were rejected under 35 U.S.C. §103 as being unpatentable over Stallmo, in view of Baylor, and in further view of Karr, US Patent No. 3,993,862, hereinafter Karr.

Applicant respectfully notes that claims 7, 13, and 59-60 are dependent claims that depend from independent claims believed to be in condition for allowance. Accordingly, claims 7, 13, and 59-60 are also believed to be in condition for allowance.

All independent claims are believed to be in condition for allowance.

All dependent claims are believed to be dependent from allowable independent claims.

The Applicant respectfully solicits favorable action.

Please charge any additional fee occasioned by this paper to our Deposit Account No. 03-1237.

Respectfully submitted,

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